PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2000-147004
(43)Date of publication of application : 26.05.2000

(51)Int.Cl. G01R 1/067
H01L 21/66

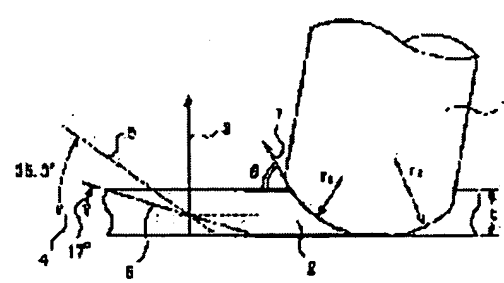
(21)Application number : 11-241690
(22)Date of filing : 27.08.1999

(71)Applicant : MITSUBISHI ELECTRIC CORP
(72)Inventor : TAKEMOTO MEGUMI
MAEKAWA SHIGEKI
KASHIBA YOSHIHIRO
DEGUCHI YOSHINOBU
MIKI KAZUNOBU

(30)Priority
Priority number : 10245881 Priority date : 31.08.1998 Priority country : JP

(54) PROBE NEEDLE FOR WAFER TEST AND ITS PRODUCTION METHOD AND SEMICONDUCTOR DEVICE TESTED WITH THE PROBE NEEDLE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a probe needle which surely obtains electrical contact by a small needle slide by making the true contact area of between the probe needle tip end and an electrode pad and having high productivity, a production method and a semiconductor device tested with the probe needle.
SOLUTION: The tip end and an electrode pad 2 are electrically contacted, by pressing the tip end of a semiconductor integrated circuit to the electric pad for testing the function of the semiconductor integrated circuit using a probe needle 1 for wafer test. The probe needle 1 is constituted of a side part and a tip end part. The tip end part is a spherical curve, of which a radius of curvature (r) for an electrode pad thickness (t) is made such that 9t≤r≤35t.



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LEGAL STATUS

[Date of request for examination]	05.01.2001
[Date of sending the examiner's decision of rejection]	
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]	
[Date of final disposal for application]	
[Patent number]	3279294
[Date of registration]	22.02.2002
[Number of appeal against examiner's decision of rejection]	
[Date of requesting appeal against examiner's decision of rejection]	
[Date of extinction of right]	

* NOTICES *

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] It is the probe needle of the semiconductor device which a point is pressed to the electrode pad of a semiconductor integrated circuit, electric contact of the above-mentioned point and the above-mentioned electrode pad is carried out, and the above-mentioned probe needle consists of a lateral portion and a point in the probe needle for a wafer test which tests actuation of a semiconductor integrated circuit, and is characterized by for the above-mentioned point to be a spherical curved surface, and to set the radius of curvature r of the above-mentioned curved surface to 9 t<=r<=35t to electrode pad thickness t for a test.
[Claim 2] In the probe needle for a wafer test which presses a point to the electrode pad of a semiconductor integrated circuit, is made to carry out electric contact of the above-mentioned point and the above-mentioned electrode pad, and tests actuation of a semiconductor integrated circuit The above-mentioned probe needle consists of a lateral portion and a point, and the above-mentioned point is a spherical curved surface. And the above-mentioned curved surface As opposed to the slip direction at the time of a needle sliding on a probe needle relatively [pad / electrode] further, and moving it after contacting an electrode pad The probe needle for a test of the semiconductor device characterized by having made larger than the curvature of the second curved surface of the opposite side the curvature of the first curved surface about located in the direction, and setting the radius of curvature of the first curved surface of the above to 7-30 micrometers.
[Claim 3] In the manufacture approach of the probe needle for a test of a semiconductor device according to claim 2 The process which roughs the curved surface of a point by electrolytic polishing or polish by the abrasive grain, and is made into the spherical curved surface of axial symmetry, The manufacture approach of the probe needle for a test of the semiconductor device equipped with the process which the thick film containing the polish abrasive grain which fixed on the substrate in which elastic deformation is possible, or abrasives is sideslipped on the polish member which consists of a thick film which fixed through fixing or a metal membrane on the front face, and in which elastic deformation is possible, and finish-machines.
[Claim 4] It is the probe needle for a test of the semiconductor device characterized by the surface roughness of the point of the above-mentioned probe needle being 0.4 micrometers or less in the probe needle for a test of a semiconductor device according to claim 1 or 2.
[Claim 5] The probe needle for a test of the semiconductor device characterized by having made a part of point [at least] of the above-mentioned probe needle about in agreement in the direction of a scrub of the probe needle to an electrode pad, and equipping it with a detailed crevice in the probe needle for a test of the semiconductor device of claim 4.
[Claim 6] The manufacture approach of the probe needle of the semiconductor device equipped with the process which processes the curved surface of a point on an outline spherical curved surface by electrolytic polishing or polish by the abrasive grain, and the process which is made to move the above-mentioned insertion or resin top to the resin containing a polish abrasive grain or a polish abrasive grain, make about in agreement in the direction of a scrub of the probe needle to an electrode pad, and form a

detailed crevice in the manufacture approach of the probe needle of a semiconductor device according to claim 5 for a test for a test.

[Claim 7] It is the probe needle for a test of the semiconductor device characterized by the above-mentioned probe needle having consisted of a metallic material which comes to sinter the powder-like Hara material, having heat-treated to the above-mentioned probe needle, and processing temperature having made the heat treatment condition below the recrystallizing temperature of the above-mentioned metallic material in the non-oxidizing atmosphere, having raised the pressure of the above-mentioned non-oxidizing quality gas in the probe needle for a test of a semi-conductor according to claim 1 or 2, and pressurizing.

[Claim 8] The semiconductor device characterized by having accumulated the electrode pad ingredient in the shape of a layer, having excluded it, and testing it by pressing the probe needle for a test of a semiconductor device given in either of claims 1, 2, 4, 5, and 7 to the electrode pad of the above-mentioned semiconductor device, and carrying out relative slipping of an electrode material and the above-mentioned probe needle.

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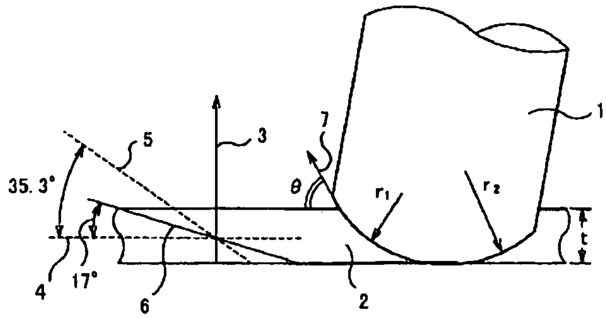
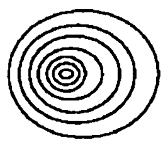
Drawing selection Representative drawing



1：プローブ針
2：パッド
3：パッドの結晶配向
4：(111)の滑り面
5：(110), (101), (011)の滑り面
6：最小の滑り面
7：針先の接線方向のベクトル



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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the semiconductor device tested with the probe needle, its manufacture approach, and its probe needle for performing the test of an electrical-characteristics check of a semiconductor integrated circuit (wafer test), the display test of a display device, or the operation test of an electronic-circuitry substrate.
[0002]
[Description of the Prior Art] As shown in drawing 13 (a), when a tip attached the probe needle 202 bent by the ** type in the probe card 201 moving up and down and pressed the conventional probe needle against the test electrode pad (an electrode pad is called below) of a semiconductor integrated circuit, it was testing by tearing the oxide film of an electrode pad front face, and carrying out true contact (electric contact) to an electrode pad new field (probing). The situation at the tip of a probe needle in the case of this probing is shown in drawing 13 (b). Magnitude etc. is modeled in order to give explanation intelligible. it is shown in drawing 13 (b) -- as -- the tip 200 of the conventional probe needle -- from the first -- the tip -- a flat -- finish -- **** -- since it is, at the time of probing, the whole tip flat section contacts first, and it becomes probing [that the oxide film 204 of the front face of the electrode pad 203 and the surface contaminant have intervened].
[0003] Furthermore, a probe is pushed against an electrode pad, the needle point of the needle which inclined by what 50-100 micrometers is caudad pushed in for (overdrive) is sideslipped, the flow part 206 which some oxide films 204 are torn and electric-true-contacts is made, and a continuity test is performed. At this time, a probe needle rotates a little by bending. Therefore, in the probe card which has the needle of the a large number book with which the tip attached in the card was processed into the flat, the include angle of the flat side of a needle point tends to become an ununiformity at the time of an overdrive, and there is a problem that a contact condition is not stabilized.
[0004] Moreover, in order not to attach a blemish to JP,6-61316,A at the electrode pad of a semiconductor integrated circuit, spherical or the example formed in the shape of an ellipse ball is shown in the tip of a probe needle. In this case, unlike that by which the tip was processed into the flat, a problem like dispersion in a touch area is not generated.
[0005] Moreover, according to JP,8-166407,A, it is the probe needle for a test (final test) of the lead part of a semiconductor device, but as a result of stabilizing a touch area for the same reason with the above being spherical to the tip processed into the flat by setting the radius of curvature r at the tip of a probe needle to 5R (R being the diameter of the point of a needle) from 0.5R, the temperature rise of a probe needle is controlled and the example which prevents joining of Sn is shown. As for the min of radius of curvature here, it is specified as the minimum curvature, the limitation, shape of i.e., a semi-sphere, on processing. Moreover, the reason for a setup of the greatest 5R is explained for preventing that the ridgeline of the boundary of a lateral portion and the tip spherical-surface section shaves off Sn plating.
[0006] Moreover, the structure which carries out line contact is shown in the electrode pad in the probe needle tip at JP,5-273237,A. According to this, it is supposed that measurement will become it is

accurate and possible without a probe needle sliding, even if an electrode pad becomes small, and it is indicated that the configuration of a point as shown in drawing 14 is good.
[0007] Furthermore, there is an example shown in drawing 15 which constituted the tip of a probe needle from the 1st field 207 which becomes parallel when the electrode pad of a semiconductor device is made to contact, and the 2nd field 208 which becomes parallel at the time of a test in JP,8-152436,A. According to this, the 2nd field and a good contact condition are maintained by making the oxide film of an electrode pad exfoliate in respect of the 1st, and exposing a front face without an oxide film. The 2nd field is taken 3 times of the 1st field, and reservation of a touch area is achieved.
[0008] Moreover, since the tungsten currently used for the probe ingredient is a powder sintered compact, in order that adhesion may tend to set it if processing of a tip configuration has large surface roughness although electrolytic polishing is used in many cases, the approach of making surface roughness small is shown to above-mentioned JP,8-166407,A by by devising an electrolytic condition. Moreover, the effectiveness of making a tip into a mirror plane similarly is shown also in JP,8-152436,A.
[0009]
[Problem(s) to be Solved by the Invention] As the conventional probe needle was constituted as mentioned above and shown in drawing 13 , the true touch area (electric flow part 206) of a probe needle tip and an electrode pad was extremely small at the time of an electrical property test, and the case where sufficient flow was not obtained was in it. Moreover, by repeating probing, since the oxide film 204 accumulated at the tip 200 of a needle, the true touch area with an electrode pad decreased, and there was a trouble that a flow became unstable.
[0010] Furthermore, even if it could aim at reduction of stress by making a point into the shape of the spherical surface, since removal of an oxide film was inadequate, reservation of a truth touch area was not completed too. That is, the aluminum oxide which survival of the aluminum oxide film directly under the spherical surface has barred stable contact even if a touch area becomes large, and adheres to a point with the increment in the count of contact needed to be frequently removed by a certain frequency.

[0011] Furthermore, in the case of drawing 15 which performs exfoliation of an oxide film and reservation of true contact by different ****** as structure proposed in order to solve the problem of this oxide film survival, the result with a good initial state was obtained, but the needle which generates a poor contact arose as the number of contacts was piled up. The following things were found out as a result of observing and analyzing the condition of a needle about this problem. That is, if the 2nd contact surface is made to contact an electrode pad and the count of a test is piled up, aluminum will have adhered to this 2nd field, and when this aluminum oxidizes, increase of contact resistance will be brought about. After Rhine after exchanging the wafer of a semi-conductor stops that is, it is thought also from having been generated in many cases, when interruption of the test for about several minutes or more occurred that above-mentioned presumption is appropriate to especially this phenomenon. In addition, although there were a needle which a poor contact generates, and a needle which is not so, also from many needles contacting coincidence at an electrode pad, this was presumed to be based on include-angle dispersion of a field, is difficult to process the 1st and 2nd flat surface with high precision in the configuration of drawing 1515 , and had a problem to the package multi-pin measurement to which it will increase increasingly from now on.
[0012] Moreover, there was a problem which carries out polish processing of the needle front face of the aluminum which is an electrode material having eaten into a polish blemish, and this aluminum having oxidized, and starting a poor contact. Moreover, generally it also became clear that the interior has a hole defect since a tungsten probe needle ingredient is a sintered compact, aluminum eats into this hole, this aluminum oxidized, a poor contact was induced, and it had been a problem.
[0013] Moreover, when wirebonding which is a back process about the semiconductor device inspected with the probe needle was performed, it had become the cause by which probe marks reduced the bonding yield. Although to also make probe marks size small was desired when an electrode pad was made small in connection with this and bonding size was made small at coincidence, although the

semiconductor device needed to be made small in order to be able to take the semiconductor device per one wafer and to make a number increase especially, probe marks size was come to acquire stable contact size, and a kink colander was not obtained, but, as a result, the bonding yield fell.
[0014] This invention was made in order to cancel the above troubles, it enlarges the true touch area of a probe needle tip and an electrode pad, and positive electric contact is acquired by the small needle slippage, and it offers the high probe needle and its manufacture approach of productivity.
[0015] Moreover, the probe needle and its manufacture approach of the maintenance free in which aluminum does not adhere at a tip are offered.
[0016] Moreover, a reliable semiconductor device is offered by making probe marks small.
[0017]
[Means for Solving the Problem] The probe needle for a test of the semiconductor device concerning the 1st configuration of this invention In the probe needle for a wafer test which presses a point to the electrode pad of a semiconductor integrated circuit, is made to carry out electric contact of the above-mentioned point and the above-mentioned electrode pad, and tests actuation of a semiconductor integrated circuit The above-mentioned probe needle consists of a lateral portion and a point, and the above-mentioned point is a spherical curved surface, and it sets the radius of curvature r of the above-mentioned curved surface to 9 t<=r<=35t to electrode pad thickness t.
[0018] Moreover, the probe needle for a test of the semiconductor device concerning the 2nd configuration of this invention In the probe needle for a wafer test which presses a point to the electrode pad of a semiconductor integrated circuit, is made to carry out electric contact of the above-mentioned point and the above-mentioned electrode pad, and tests actuation of a semiconductor integrated circuit The above-mentioned probe needle consists of a lateral portion and a point, and the above-mentioned point is a spherical curved surface. And the above-mentioned curved surface As opposed to the slip direction at the time of a needle sliding on a probe needle relatively [pad / electrode] further, and moving it after contacting an electrode pad The curvature of the first curved surface about located in the direction is made larger than the curvature of the second curved surface of the opposite side, and the radius of curvature of the first curved surface of the above is set to 7-30 micrometers.
[0019] Moreover, the manufacture approach of the probe needle for a test of the semiconductor device concerning the 1st configuration of this invention The process which roughs the curved surface of a point by electrolytic polishing or polish by the abrasive grain, and is made into the spherical curved surface of axial symmetry in the probe needle of the 2nd configuration, It has the process which the thick film containing the polish abrasive grain which fixed on the substrate in which elastic deformation is possible, or abrasives is sideslipped on the polish member which consists of a thick film which fixed through fixing or a metal membrane on the front face, and in which elastic deformation is possible, and finish-machines.
[0020] Moreover, the probe needle for a test of the semiconductor device concerning the 3rd configuration of this invention sets surface roughness of a point to 0.4 micrometers or less in the 1st or the probe needle of the configuration of two.
[0021] Moreover, in the probe needle of the 3rd configuration, the probe needle for a test of the semiconductor device concerning the 4th configuration of this invention makes a part of point [at least] about in agreement in the direction of a scrub of the probe needle to an electrode pad, and equips it with a detailed crevice.
[0022] Moreover, the manufacture approach of the probe needle for a test of the semiconductor device concerning the 2nd configuration of this invention The process which processes the curved surface of a point on an outline spherical curved surface by electrolytic polishing or polish by the abrasive grain in the probe needle of the 4th configuration, The front face of insertion or the above-mentioned resin is moved to the resin containing a polish abrasive grain or a polish abrasive grain, and it has the process which is made about in agreement in the direction of a scrub of the probe needle to an electrode pad, and forms a detailed crevice.
[0023] Moreover, in the 1st or the probe needle of the configuration of two, the above-mentioned probe needle consists of a metallic material which comes to sinter the powder-like Hara material, and the

probe needle for a test of the semiconductor device concerning the 5th configuration of this invention heat-treats to the above-mentioned probe needle, and processing temperature makes the heat treatment condition below the recrystallizing temperature of the above-mentioned metallic material in a non-oxidizing atmosphere, and it raises and pressurizes the pressure of the above-mentioned non-oxidizing gas.
[0024] Moreover, the semiconductor device concerning the 1st configuration of this invention presses a probe needle given in the configuration of either the 1st thru/or 5 to the electrode pad of a semiconductor device, and it is carrying out relative slipping of an electrode material and the above-mentioned probe needle, and an electrode pad ingredient is accumulated in the shape of a layer, is excluded, and it tests it.

[0025]
[Embodiment of the Invention] The gestalt of operation of gestalt 1. this invention of operation is explained using drawing. Drawing 1 and drawing 2 are the explanatory views showing the condition of the probe needle by the gestalt 1 of operation of this invention, and an electrode pad. In drawing, 1 is a probe needle, 2 is an electrode pad, and it is the aluminum-Cu film with a thickness of about 0.8 micrometers with common logic system integrated semiconductor equipments, such as DRAM. In the semiconductor device of particular applications, such as an object for power, some which are 2-3 micrometers have pad thickness. For the tangential direction vector of the needle point, and 8, as for an oxide-film adhesion part and 10, an electrode pad scaling coat and 9 are [the crystal orientation whose 3 is an electrode pad and 4, 5 and 6 / the sliding surface and 7 / an electric flow part and 11] the pieces of shear.
[0026] As shown in drawing 2 , in the case of probing, the electric flow section of the probe needle 1 and the electrode pad 2 tears the oxide film 8 of the front face of the electrode pad 2 by letting the probe needle 1 slide, and is obtained by contacting an electrode pad new field. In addition, to the field of the electrode pad 2, the probe needle 1 shows the case of 8 times where fell and it has an include angle here rather than is perpendicular, and the relative skid of the probe needle 1 and the electrode pad 2 generates it with this include angle. moreover, the 1st curved surface of the curvature r1 the contour line of a point is [the curvature] dense although the account of the average of the contour map when seeing the probe needle 1 from the bottom is carried out and a contour line -- rough -- it consists of curved surfaces of the curvature r2 which is that it is ****, and these two fields are the continuous spherical curved surfaces.
[0027] There was nothing that clarifies a phenomenon in the viewpoint of deformation by contact of the needle point and an aluminum pad in the conventional invention, and proposes an appropriate configuration and an appropriate ingredient to this, though it was regrettable. Then, examination and an experiment were wholeheartedly added about antisticking of the method of producing this shear strain easily, and aluminum. A shear strain is produced along with the sliding surface of a metallic crystal. On the other hand, the crystal orientation 3 of the electrode pad 2 at the time of a spatter is the so-called C shaft orientation which was equal to (111). this (111) -- the include angle which the sliding surface 4 makes with an electrode pad is 0 times. Moreover, in other sliding surfaces, it is an electrode pad front face and the sliding surface 5 where the include angle to make is the smallest (011 (101 (110))), and the include angle is 35.3 degrees. Supposing shearing cannot happen only at an angle of the sliding surface, it should shear only with the discontinuous value [say / 0 times or 35.3 degrees].
[0028] However, from the experimental result, it turned out that it has sheared at an angle of [of the sliding surfaces 4 and 5 instead of a discontinuous value] middle. This is because the shear 11 as shearing along the above-mentioned sliding surface 4 and the above-mentioned sliding surface 5 shows to union ****** and drawing 2 is starting. Once slipping arises in the direction of the sliding surface 4 (0 times) now, the slider of this direction will receive the compressive force of a direction 0 times, and slipping will come to be prevented from advancing more than it. For this reason, it will be in the condition of being easy to produce slipping of a direction rather than slipping of a direction 35.3 degrees 0 times, and then slipping of a direction will arise 35.3 degrees. If slipping of the direction of 35.3 degrees arises [the include angle theta of ****** of drawing 1 , and a pad side] when smaller than 35.3 degrees, since a slider will be stuffed into narrower space, advance of slipping beyond it will be barred.

In this condition, it is thought that it will be in the condition of being easy to produce slipping of a direction rather than slipping of a direction 0 times 35.3 degrees, slipping of a direction and slipping of the direction of 35.3 degrees arise [again] repeatedly by turns 0 times, and shearing of the middle include angle of 0 times and 35.3 degrees arises as a result of this combination.
[0029] According to the experiment which the include angle of the tangential direction 7 of the needle point was changed, and performed it, the include angle of the tangential direction 7 of the needle point and electrode pad side from which such shearing may happen is 15 - 35 degrees, and the include angle to which it is stabilized and shearing happens is 17 - 30 degrees. Therefore, from 15 degrees, 35 degrees, desirably, if the include angle which the tangential direction vector 7 of the needle point makes with an electrode pad front face is the needle point configuration which becomes 30 degrees from 17 degrees, it can tear the oxide film 8 of an electrode pad front face, an electrode pad new field can be contacted, and sufficient electric flow comes to be obtained. If the conditions from which the above-mentioned tangent include angle is obtained are expressed with the radius of curvature r of the needle point, and the relation of thickness t of an electrode pad, it will be set to 6 t<=r<=30t and 8 t<=r<=23t, respectively. Such a phenomenon is seen in common with face-centered cubic lattice metals, such as aluminum, Au, Cu, an aluminum-Cu alloy, and aluminum-Si.
[0030] The probe marks attached to the aluminum pad 2 are shown in drawing 3 using this probe needle 1. Since the aluminum 31 discharged by the end of the probe has stratified (lamellae) structure, it turns out that the end of the probe followed the test pad ingredient, and has caused the shear strain. Exceeding 0.8 micrometers in thickness of an aluminum pad, in this example, the laminating of the above-mentioned layer structure is carried out by the thickness of about 1.5 micrometers, and it serves as an exclusion gestalt which forms a projection in the front face of the slip direction of the needle point on an aluminum pad. The conventional example of this exclusion condition is shown in drawing 4 . In the case of this conventional example, it turns out that exclusion has hardly occurred in the front face of a slip direction.
[0031] The problem the case, a flat [the conventional tip], and in the globular form, in which the tip had big curvature became clear [that it can explain by the following two phenomena] from the analysis of the mechanism of the above contact, observation of an exclusion condition, etc. First, in the front face of the slip direction of a needle, deer formation of the projection by exclusion is not carried out only, but electric contact is performed under a needle or in back. However, neither under a needle nor in back, since a sliding surface and the pressurization direction are not in agreement, a new field can be formed easily. That is, an oxide film remains in the interface of a needle and an electrode pad. For this reason, even if a new field is a part, it enables it to aim at electric contact somehow by taking a large touch area. As the 2nd phenomenon, when a new field is formed, the problem of the adhesion of the aluminum to a needle occurs. This agglutinate aluminum oxidizes, and when balking removal cannot be carried out at the time of the following probing, a poor contact occurs.
[0032] On the other hand, in this invention, a new field is formed in the front face of a needle that whenever [contact angle / of an electrode pad front face and a needle] is easy to generate a skid, this sticks (it is the configuration which the force of the direction of a major axis of a needle joins), and it becomes the electric contact surface. However, although the adhesion of aluminum occurs in this field as well as the conventional example, since it is located in the slip direction of a needle at the time of the following probing, the big balking force is added, and is removed and contact to a new field can always secure. Therefore, it is a place near the side face of the second curved surface which does not need electric contact that the aluminum adhesion section remains in this invention. Although the result which carried out the continuity check using this needle and the conventional flat needle is shown as compared with drawing 5 , at the conventional (b), defective continuity has not happened in the count of contact exceeding 10000 times to the poor contact to which contact resistance exceeds 1 ohm having occurred in about 500 times with the needle of this invention shown in (a).
[0033] Next, the effectiveness over the semiconductor device using this probe needle is explained. According to this invention, the marks the probe needle carried out [marks] the relative skid to the electrode pad of a semiconductor device are formed, and the exclusion section which accumulated the

ingredient in the shape of a layer is formed especially in the point. Although it is formed even if probe marks use the conventional probe needle, for wirebonding of a back process, as small the one as possible is desirable. High integration of a circuit part is attained as wiring width of face becomes small, in order to make a semiconductor device small especially, and the need of also making an electrode pad small in connection with this occurred. However, with the conventional probe needle, since stability got still worse, it was not employable to make probe marks small. This is because the approach of forming the electric contact section in the inferior surface of tongue of a needle is taken in the former as stated above. Therefore, in the former, when width-of-face die length of about 40 micrometers of 20 micrometers was needed (drawing 3 R> 3, 4 reference) and contact was not further stabilized by probe marks, the technique of carrying out probing to the same electrode pad again was taken, and the present condition was that probe marks become still larger.

[0034] On the other hand, in this invention, probe marks were able to be sharply made small with width-of-face die length of about 20 micrometers of 12 micrometers. Furthermore, when the formation situation of a joint was observed after wirebonding, on probe marks, the formation of an alloy layer used as the index of the stability of junction is inadequate, and it turned out that the difference in probe marks size affects wirebonding nature greatly. That is, the magnitude of the wire-bonding section presupposed that diameter extent of 65 micrometers is circular to the electrode pad whose one side is 80 micrometers. One side of an electrode pad needs to be set to 65 micrometers, and it is necessary to reduce a bonding area to the diameter of about 55 micrometers in connection with it in a future semiconductor device. bonding area area 2400micrometer2 [as opposed to / when probe marks are made into area, they are 2 240 micrometers in 2 and this invention 800 micrometers at the former, and / a small electrode pad (diameter of 55 micrometers)] for -- although the conventional probe marks area serves as magnitude which degrades junction quality -- this invention -- probe marks area -- about [240micrometer2 and] -- it becomes small one third and degradation of junction quality is not produced. It was small electrode pad correspondence and there was no defect generating at this invention to 5% of poor opening having occurred in the probe conventionally in dependability especially over a long period of time.

[0035] Here, if the radius of curvature of a probe needle is made small, the pressure which joins an electrode pad will become high, and it produces and cheats out of the damage on the electrode pad of a semiconductor device (crack). Usually, in the conventional needle, although the probe needle was pushed against the semiconductor device by the force of 7gf extent, when the part and load which made the touch area small were set to 3gf(s), the poor contact occurred. With the conventional needle, by taking a large touch area, this is because it was designing so that an electric flow might be obtained even when a new field benefited dispersion small, relatively, the area of a new field is also small, and varies, and serves as a poor contact with a small touch area. Therefore, it turned out that it is effective in prevention of damage on the configuration electrode pad which takes a large area at the bottom (spherical curved surface of curvature r2) on the front face and inferior surface of tongue supporting stylus pressure, maintaining at the configuration (spherical curved surface of curvature r1) which is easy to form the new field of an electrode pad to the front of the slip direction of a needle like this invention. That is, in this invention, electric contact is secured and the second curved surface which is an inferior surface of tongue is divided into the role which lowers stress on the first curved surface which is a front face. Since he is trying for a touch area to become the largest at the time of the overdrive completion to which a needle rotates slightly and stylus pressure becomes the highest by the overdrive at this time, the pressure which joins an electrode pad can be lowered.

[0036] Moreover, even if the height of the needle which has a large number by making a point into a spherical field varies (there is usually about 10-micrometer dispersion), unlike the flat side by which the conventional proposal is made, it is effective in a touch area being stabilized. In addition, although the breaking load which joins the needle when pushing in only the predetermined amount of overdrives can be set as a desired value by adjusting the size and die length of a probe needle, it is unavoidable to increase as the overdrive of the load is carried out. Since it constituted so that the touch area of a needle tip and an electrode pad may increase with an overdrive in this invention, even if the height of a needle varied, the pressure which joins a semiconductor device did not increase so much, but was able to

prevent the damage.
[0037] In addition, although the probe needle 1 broke down from the above-mentioned continuity check and the include angle was made into 8 times, it of a common probe needle is just over or below 6 times, and can expect large effectiveness to contact stability also with this include angle. However, since the touch area is small restricted in this invention, when it also takes into consideration preventing the flash from the electrode pad 2, it is desirable [it is good to fall on preventing a damage and to enlarge an include angle, and] that it takes 8 times or more for less than 12 degrees.
[0038] The approach and equipment which forms easily in a point the first curved surface shown above and the second curved surface were found out to coincidence. The approach is as follows and is shown in drawing 6 . In drawing, 12 is the electrolytic solution. First, it is processed almost spherically [the request of axial symmetry] by general electrolytic polishing or the polish using the abrasive grain of Si of a point. Next, the curved-surface configuration symmetrical with a non-shaft of having the 1st curved surface where curvature is big, and the 2nd curved surface where curvature is small is formed using the polish equipment which fixed the polish member in which elastic deformation is possible on a substrate. As a polish member, the thick film containing abrasives in which elastic deformation is possible, or the thick film which fixed abrasives through fixing or a metal membrane on the front face and in which elastic deformation is possible can be used. Specifically, what formed coating or 2 micrometers of TiN film 16 which pastes up, forms 100A of thin films 15 of Ti on this, and serves as abrasives further for the sheet 14 of polyimide with a thickness of 50 micrometers can be used on a silicon substrate 13. Moreover, similarly what fixed the resin thickness film with a thickness [containing Si abrasive grain] of 300 micrometers can be used on a silicon substrate.
[0039] Polish of the needle point is in the condition which attached the probe needle in the probe card, is pressed against the aforementioned polish member and performed by making it move up and down repeatedly in the bigger amount (several 100 micrometers) of overdrives than the amount of overdrives at the time of a wafer test. The tip of the probe needle attached in the probe card by inclining sideslips a polish member top by vertical movement of a probe card. At this time, it sinks so that a polish member may hold the spherical surface of the needle point by elastic deformation, and the 2nd curved surface which mainly has radius of curvature r2 is formed. Radius of curvature r2 can be adjusted with the thickness and the elastic coefficient of a polish member. In addition, since only predetermined distance sideslips a front face, when it is made to get mixed up centering on this location since a probe needle is contacted to polish equipment, the second curved surface is processed more nearly alternatively and is desirable.
[0040] A polish member may fix direct abrasives into a rigid low ingredient not only above-mentioned ingredient and configuration but on a rigid high substrate. Moreover, so that it may move while the resin of the rigid shape of a low thick film containing abrasives may be made to fix and a probe needle sinks a polish equipment top slightly in short on a rigid high substrate, or it may advance into abrasives on the way If it constitutes so that it may slide on a front face preferably, the field where curvatures differ in a point easily can be formed.
[0041] Moreover, also although it is called the same spherical surface, the stability of contact differs greatly by whether as mentioned above, a shear strain of an electrode pad occurs easily. Although the result of having changed radius of curvature to about 0.8 micrometers in thickness of the electrode pad of common integrated semiconductor equipments, such as DRAM, and having carried out the same trial is shown in drawing 7 , the good result is obtained in the contact life and the radius of curvature of 7-30 micrometers is 10-20 micrometers preferably. In 7 micrometers or less, since radius of curvature is too small, sufficient force for the first field of an electric flow side is not added, and since area is small, it becomes a problem, and 20-30 micrometers of an upper limit are mostly in agreement with 24 micrometers which is the upper limit of the range which shearing of the electrode pad mentioned above generates.
[0042] In addition, what is necessary is just to perform same management based on the relation it is [1<=35t of 9 t<=r] unrelated, although the proper radius of curvature r1 will also change according to it if electrode pad thickness differs.

[0043] In addition, it is not necessary to be the perfect spherical surface in fact, and in order to explain plainly the relation of the include angle of the sliding surface and the end-of-the-probe configuration where a shear strain of an electrode pad ingredient takes place, it was illustrated and explained, having used the configuration of a probe needle apical surface as the spherical surface, but the same effectiveness can be acquired if it is a curved-surface configuration near the spherical surface.
[0044] Moreover, although the aluminum-Cu alloy was mentioned as the example with the gestalt of this operation as a test pad ingredient, the same effectiveness can be acquired if electrode pad ingredients are ingredients, such as aluminum, aluminum which carries out the same slip (shear strain), and an aluminum-Si-Cu alloy, copper.
[0045] Gestalt 2. drawing 8 of operation is the result of showing the surface roughness of the probe needle by the gestalt 2 of operation of this invention, and the relation of the count of contact to which contact resistance exceeds 1 ohm, and examining using a probe needle with a radius of curvature [of a tip] of 15 micrometers to DRAM with a thickness [of an electrode pad] of about 0.8 micrometers. When surface roughness was as coarser as 1 micrometer than this, the life was greeted by about 20000 times, but when field roughness was raised by electrolytic polishing etc., it is about 0.4 micrometers or less, and it turned out that the count of contact can be increased rapidly. When it is made especially 0.1 micrometers, it amounts to 380,000 times, and an about 20 times [in case surface roughness is 1 micrometer] as many life as this can be attained. This could be guessed because the oxide stopped being able to adhere at the tip of a probe needle easily, and within limits shown with the gestalt 1 of the above-mentioned implementation, even if it changed the thickness of an electrode pad, or the radius of curvature at the tip of a probe needle, the almost same result was obtained.
[0046] Gestalt 3. drawing 9 of operation is the explanatory view showing the appearance configuration at the tip of the probe needle by the gestalt 3 of operation of this invention, and, in (a), (b) looks at the point of a probe needle from a transverse plane from width. In drawing, it is the crevice which prepared 1 at the tip of the probe needle 1 at the probe needle, and prepared 17 in the radial. Like the gestalt 2 of the above-mentioned implementation, the front face of a probe needle with a radius of curvature [of a tip] of 15 micrometers was used for various surface roughness, the polish abrasive grain was used for finishing and a pan, the polish blemish was prepared in the radial from the tip core of a probe needle, the crevice was formed, and these probe needles were used for the trial of DRAM with a thickness [of an electrode pad] of about 0.8 micrometers. Drawing 10 shows the relation of the count of contact until the surface roughness and contact resistance of a probe needle by the gestalt 3 of operation of this invention exceed 1 ohm, and shows it as compared with the probe needle (broken line) of only general polish with which the crevice was formed at random. Drawing shows that the count of contact is increasing remarkably compared with the thing of only polish with the common probe needle which established the crevice in the radial. This is considered because metals, such as aluminum of an electrode pad, carrying out plastic flow along the crevice formed in the radial, and carrying out checking and verifying to level difference parts, such as an irregular polish blemish, mechanically, when pushed and carrying out the scrub of the probe needle to an electrode pad decreased and metals, such as the above-mentioned aluminum, remaining at the tip of a probe needle, oxidizing further, and increasing contact resistance decreased.
[0047] In order to check the above-mentioned phenomenon furthermore, after examining by pushing against the electrode pad of DRAM the probe needle which used the polish abrasive grain with a particle size of 5 micrometers, and prepared the crevice in the various condition, these probe needles were observed using the scanning electron microscope (SEM). Drawing 11 is the explanatory view in which and having shown it, and is the front view of the point of a probe needle. [the SEM observation result] [**] [type] In drawing, the crevice which prepared 1 in the probe needle and prepared 17 at the tip of a probe needle, and 18 are adhesion objects, and that by which (a) established the crevice in the radial from the tip core, the thing by which (b) established the crevice in the part (part which contacts an electrode pad at least) in parallel, the thing by which (c) established the crevice in concentric circular from the tip core, and (d) prepare a crevice at random. The adhesion object 18 considered to be the oxide of aluminum ******** was observed in the condition that they are shown in drawing, respectively when

these probe needles are adjusted each other in the direction shown in the electrode pad by the drawing Nakaya mark. It compared with many adhesion objects to what established the crevice in concentric circular [of (c)] and the random of (d) from these being observed, and has checked that the adhesion to a probe needle could be prevented by making it about in agreement in the direction of a scrub, and preparing a crevice from what prepared the crevice the radial of (a) and in the shape of [of (b)] parallel having little adhesion.

[0048] The approach of making it easily about in agreement [in the direction of a scrub] at the tip of the probe needle shown above, and forming a crevice was found out to coincidence. The approach is as follows. First, it is processed spherically [a request] by general electrolytic polishing or the polish using the abrasive grain of Si of a point. Next, in forming a crevice in a radial, it thrusts a probe needle into the substrate which inserted the probe needle almost at right angles to a polish abrasive grain, or embedded the polish abrasive grain to resin, such as polyimide, or a film. Moreover, in forming a crevice in the shape of parallel, it moves a probe needle on the film which was made to move a probe needle on a polish abrasive grain, or embedded the same polish abrasive grain as the above, or the substrate which formed abrasives. In order to be able to use Si, SiC, an artificial diamond, etc. and to form the crevice of the gestalt of this operation as the above-mentioned polish abrasive grain, a thing with a particle size of 5 micrometers or less is desirable. Moreover, the above-mentioned polish abrasive grain is mixed with resin, lump hardening is carried out, and the film embedding a polish abrasive grain can be produced.

[0049] Gestalt 4. drawing 12 of operation is drawing which photoed the organization of the probe needle by the gestalt 4 of operation of this invention, and a common probe needle with the scanning electron microscope (SEM). Drawing 1212 (a) is the organization of a common tungsten probe, and drawing 12 (b) is the organization after heat-treating the above-mentioned tungsten needle. Since a tungsten probe needle is a sintered compact, a hole is included in the ingredient after sintering. Although the ingredient after sintering is rolled out by machining, drawing processing is carried out further and it is considering as the needle crystal organization in order to crush this hole, there is still 1 - 2% of hole (opening). Then, although he wants to heat-treat for crushing this opening, since the needle crystal organization of the above-mentioned tungsten ingredient will collapse and stiffen and the material strength of tungsten original will be lost if heat treatment in the temperature field which a tungsten ingredient recrystallizes is added, it cannot use for a thin probe needle like this invention. Then, the high-pressure force was comparatively applied from the exterior by whenever [low-temperature], and the approach of crushing the hole inside a tungsten ingredient by the synergistic effect of temperature and a pressure was found out.

[0050] The processing distortion (residual stress) with the metallic material remarkable inside an ingredient by which drawing processing was carried out like a probe needle remains. By this processing distortion, as for the metal atom arranged especially to the random near the grain boundary, scientific potential energy is high. Then, the big metallic material of this processing distortion was heated to the temperature below recrystallizing temperature, and processing which crushes the opening on which hydrostatic pressure is further poured from the exterior, and which is near the grain boundary inside the above-mentioned metallic material was performed. It becomes until migration of the atom of the metallic material by which the processing time is processed more than the pressure that a pressure makes generate the skid of an ingredient below the recrystallizing temperature of a bulk material stops about as heat treatment conditions, but when 300 degrees C - 600 degrees C and the processing pressure force heat-treat [processing temperature] 200 to 2000 atmospheric pressure, and the processing time in 0.5 to 5 hours, specifically, holes decrease in number. It became clear from an experiment also especially in the above-mentioned heat treatment condition range the processing temperature of 500 degrees C, 1000 or more atmospheric pressures of processing pressure force, and that a hole decreases sharply at the time beyond processing-time 1 hour.

[0051] In addition, about a flow and pressure requirement, the higher one has the short processing time and ends. Usually, it was the temperature more than the recrystallizing temperature (usually temperature of 4 - 50 percent of the melting point of the ingredient) of an ingredient, in order to crush the hole defect inside an ingredient, it heat-treated, having apply high pressure (call HIP processing), but as showed in

drawing 12 (a) and (b), in the case of the gestalt of this operation, compared with the melting point of 3400 degrees C of a tungsten, it turned out that a hole can be crush by heat treatment at temperature low a figure single [about]. Moreover, embrittlement of an ingredient does not arise compared with heat treatment more than recrystallizing temperature. In addition, although the change was checked on the same heat treatment conditions about the about 5mm thick needle, the hole defect had remained. That is, after carrying out drawing processing to the size of a 150 micrometers - about 300 micrometers probe needle, when heat-treating this invention acquired the above-mentioned effectiveness, it turned out that it is indispensable.
[0052] Furthermore, etching at the time of it being found out that crystal orientation gathers in the direction which drew a line in the probe ingredient remarkably by this heat treatment, and processing the end of the probe according to this effectiveness, and a polish rate became uniform, and it turned out that a needle tip is made with a very smooth smooth side. Consequently, oxide stopped being able to adhere at the tip of a probe needle easily, and good probing of an electric flow became possible. As surface roughness, a smooth side about 0.4 micrometers or less is good.
[0053] Moreover, since a mechanical property also becomes homogeneity (it is 2 22.3 to 26.3 kgf/mm after processing to dispersion in Young's modulus having been 2 18.8 to 25.2 kgf/mm before processing) as shown in Table 1, the excessive overdrive and excessive load in consideration of dispersion in a probe needle can be reduced by carrying out probing using the probe card furnished with the above-mentioned probe needle.
[0054]
[Table 1]

	引っ張り荷重	ヤング率
サンプル	g f	$\times 10^{3}$ kgf/mm ^{2}
熱処理前品	12.800	18.8
	12.960	25.2
	13.060	18.8
熱処理品	13.520	22.3
	13.800	23.8
	13.840	26.3

[0055] When the probe needle with a radius of curvature [of the tip of the gestalt 1 of operation] of 25 micrometers was used to the semiconductor device using this heat-treated probe needle ingredient, the possible count of continuation probing by the stable electric contact resistance can compare with the gestalt 1 of 200000 times or more and operation, stability can improve, and test time amount and test cost could decrease sharply.
[0056] Although the gestalt of operation mentioned above described the probe needle and probe card for mainly carrying out the wafer test of a semiconductor integrated circuit, also when contacting a leadframe for example, after making a semiconductor integrated circuit a package, according to the approach of contact by this invention, the good final test of an electric flow can be performed using the concept of this invention. Moreover, application is possible also for the operation test of an electronic-circuitry substrate which mounted the semiconductor integrated circuit or the display device, and good probing of an electric flow is made.
[0057]
[Effect of the Invention] As mentioned above, according to the probe needle for a test of the semiconductor device concerning the 1st configuration of this invention Since it consists of a lateral portion and a point, the above-mentioned point is a spherical curved surface and the radius of curvature r of the above-mentioned curved surface was set to 9 t<=r<=35t to electrode pad thickness t At the time of probing, an electrode pad can be shear-strained efficiently, a probe needle tip can obtain electric flow

with sufficient end of the probe and electrode pad, and the electrical property trial of a reliable semiconductor device of it is attained.
[0058] According to the probe needle for a test of the semiconductor device concerning the 2nd configuration of this invention, it consists of a lateral portion and a point and the above-mentioned point is a spherical curved surface. Moreover, the curved surface of a parenthesis As opposed to the slip direction at the time of a needle sliding on a probe needle relatively [pad / electrode] further, and moving it after contacting an electrode pad Since the curvature of the first curved surface about located in the direction was made larger than the curvature of the second curved surface of the opposite side and the radius of curvature of the first curved surface was set to 7-30 micrometers A probe needle tip can shear-strain an electrode pad efficiently at the time of probing. It becomes possible not to generate the poor bonding which can obtain without needle tip cleaning of the small contact surface which obtains electric flow with sufficient end of the probe and electrode pad, and does not do damage on a semiconductor device.
[0059] Moreover, according to the manufacture approach of the probe needle for a test of the semiconductor device concerning the 1st configuration of this invention The process which roughs the curved surface of a point by electrolytic polishing or polish by the abrasive grain, and is made into the spherical curved surface of axial symmetry in the probe needle of the 2nd configuration, Since it had the process which the thick film containing the polish abrasive grain which fixed on the substrate in which elastic deformation is possible, or abrasives is sideslipped on the polish member which consists of a thick film which fixed through fixing or a metal membrane on the front face, and in which elastic deformation is possible, and finish-machines The probe needle which can acquire the small contact surface which obtains electric flow with sufficient end of the probe and electrode pad, and does not do damage on a semiconductor device and which is not made to generate poor bonding can be made easily.
[0060] Moreover, according to the probe needle for a test of the semiconductor device concerning the 3rd configuration of this invention, it consists of a lateral portion and a point and the above-mentioned point is a spherical curved surface, and since surface roughness of the curved surface of a parenthesis was set to 0.4 micrometers or less, the probe needle which takes an electric flow from the ability of adhesion to be prevented to stability continuously further can be offered.
[0061] Moreover, according to the probe needle for a test of the semiconductor device concerning the 4th configuration of this invention Since consisted of a lateral portion and a point, and the above-mentioned point is a spherical curved surface, set surface roughness of the curved surface of a parenthesis to 0.4 micrometers or less, it was made in agreement further about in the direction of a scrub of a probe needle and the detailed crevice was formed The probe needle which takes an electric flow from the ability of adhesion to be prevented to stability continuously further can be offered.
[0062] Moreover, according to the manufacture approach of the probe needle for a test of the semiconductor device concerning the 2nd configuration of this invention The process which processes the curved surface of a point on an outline spherical curved surface by electrolytic polishing or polish by the abrasive grain in the probe needle of the 4th configuration, Since it had the process which is made to move the above-mentioned insertion or resin top to the resin containing a polish abrasive grain or a polish abrasive grain, is made about in agreement in the direction of a scrub of the probe needle to an electrode pad, and forms a detailed crevice The probe needle which takes an electric flow to stability continuously further can be easily made from the ability to prevent adhesion.
[0063] Moreover, the probe needle for a test of the semiconductor device concerning the 5th configuration of this invention It consists of a metallic material which comes to sinter the powder-like Hara material in the 1st or the probe needle of the configuration of two, and heat-treats to the above-mentioned probe needle. The heat treatment condition in a non-oxidizing atmosphere Since processing temperature carried out to below the recrystallizing temperature of the above-mentioned metallic material and raised and pressurized the pressure of the above-mentioned non-oxidizing quality gas, the hole defect of a probe needle decreases, a mechanical property becomes uniform, and the probe needle which takes an electric flow from the ability of adhesion to be prevented to stability continuously further can be offered.

[0064] Moreover, in a probe needle given in either the 1st thru/or the configuration of five, since the semiconductor device concerning the 1st configuration of this invention was carrying out relative slipping of an electrode material and the above-mentioned probe needle, accumulated the electrode pad ingredient in the shape of a layer, excluded [it pressed to the electrode pad of a semiconductor device, and] it and made it small probe marks, it can prevent poor wirebonding.

[Translation done.]

DESCRIPTION OF DRAWINGS

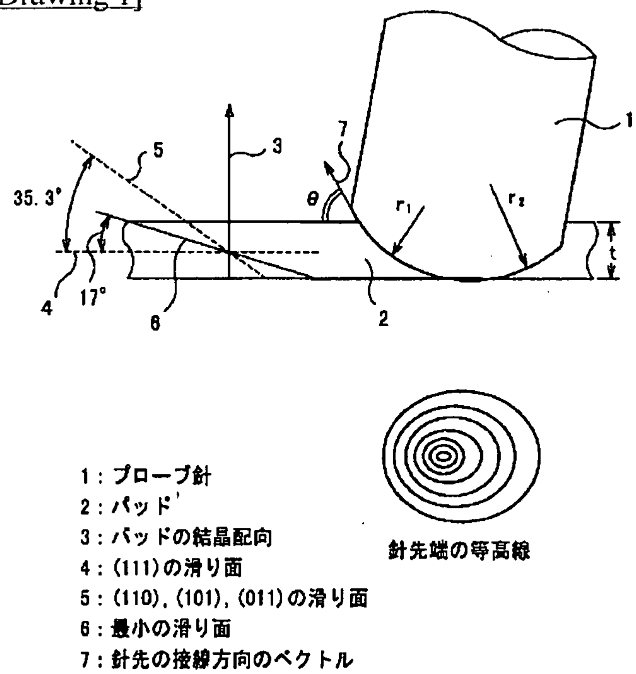
[Brief Description of the Drawings]
[Drawing 1] It is the explanatory view showing the condition of the probe needle by the gestalt 1 of operation of this invention, and an electrode pad.
[Drawing 2] It is the explanatory view showing the condition of the probe needle by the gestalt 1 of operation of this invention, and an electrode pad.
[Drawing 3] It is the explanatory view showing the probe marks attached to the aluminum electrode pad with the probe needle by the gestalt 1 of operation of this invention as compared with the case of a common probe needle.
[Drawing 4] It is the explanatory view showing the probe marks attached to the aluminum electrode pad with the probe needle by the gestalt 1 of operation of this invention as compared with the case of a common probe needle.
[Drawing 5] It is the explanatory view showing the contact stability at the time of using the probe needle by the gestalt 1 of operation of this invention as compared with a general example.
[Drawing 6] It is the explanatory view showing the condition of the probe needle by the gestalt 1 of operation of this invention, and polish equipment.
[Drawing 7] It is the explanatory view showing the contact stability at the time of using the probe needle by the gestalt 1 of operation of this invention, and the relation of a tip configuration.
[Drawing 8] It is the property Fig. showing the surface roughness of the probe needle by the gestalt 2 of operation of this invention, and the relation of the count of contact to which contact resistance exceeds 1 ohm.
[Drawing 9] It is the explanatory view showing the appearance configuration at the tip of the probe needle by the gestalt 3 of operation of this invention.
[Drawing 10] It is the property Fig. showing the relation of the count of contact until the surface roughness and contact resistance of a probe needle by the gestalt 3 of operation of this invention exceed 1 ohm.
[Drawing 11] It is the explanatory view [-izing / the result of having carried out SEM observation of the probe needle by the gestalt 3 of operation of this invention / the explanatory view / the ** type].
[Drawing 12] It is drawing which photoed the organization of the probe needle by the gestalt 4 of operation of this invention, and a common probe needle by SEM.
[Drawing 13] It is the explanatory view showing the condition of conventional probe equipment and a probe needle, and an electrode pad.
[Drawing 14] It is the explanatory view showing another conventional probe needle.
[Drawing 15] It is the explanatory view showing still more nearly another conventional probe needle.
[Description of Notations]
1 Probe Needle, 2 Electrode Pad, 3 Crystal Orientation of Electrode Pad, 4 (111) The sliding surface of the sliding surface, 5 (110), (101), and (011), 6 The minimum sliding surface, 7 The tangential direction vector of the needle point, 8 Electrode pad scaling film, 9 An electric flow part, 10 An oxide-film adhesion part, 11 Shear, 12 The electrolytic solution, 13 A substrate, 14 resin, 16 Abrasives, 17 Crevice,

18 An adhesion object, 31 Aluminum discharged by the end of the probe, 200 The tip of a probe needle, 201 A probe card, 202 A probe needle, 203 An electrode pad, 204 The electrode pad scaling film, 205 A probe needle "heel" part, 206 Electric flow part.

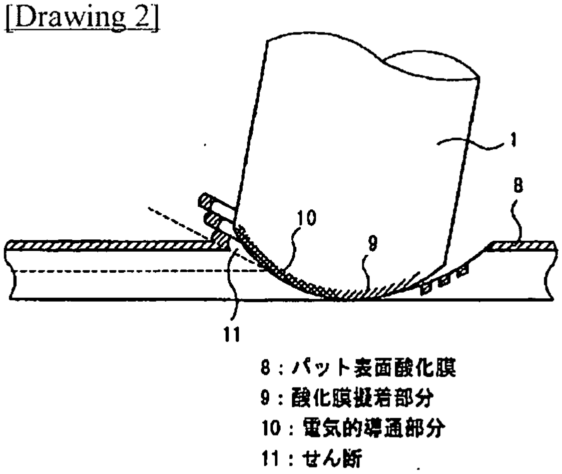
[Translation done.]

DRAWINGS

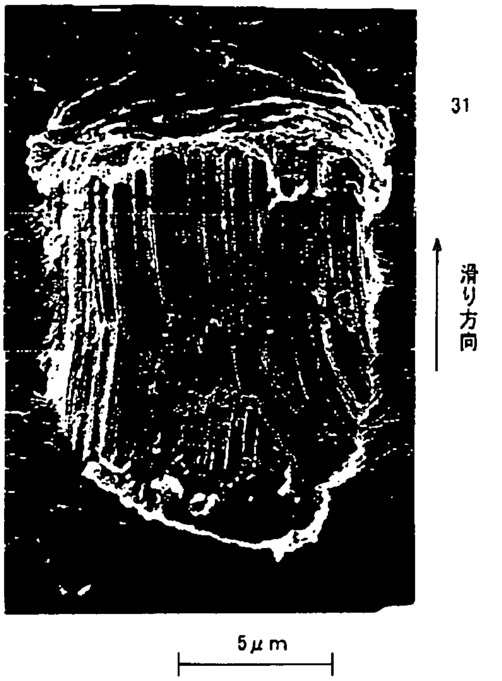
[Drawing 1]



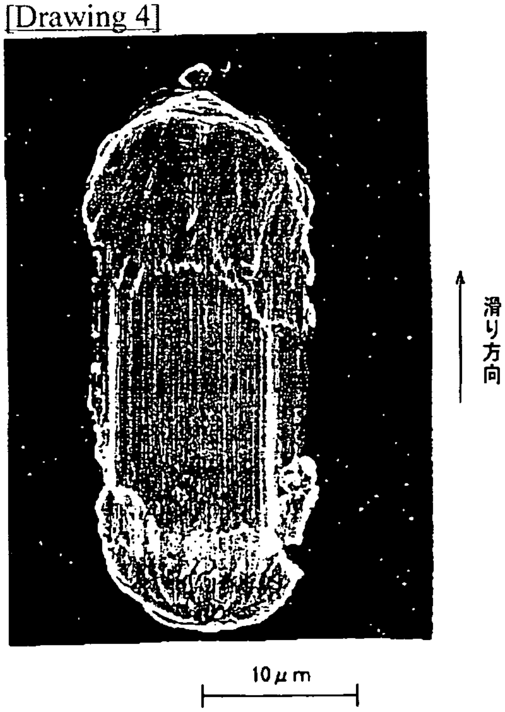
[Drawing 2]



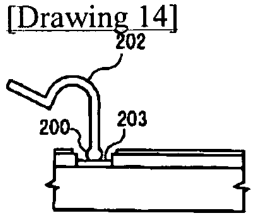
[Drawing 3]



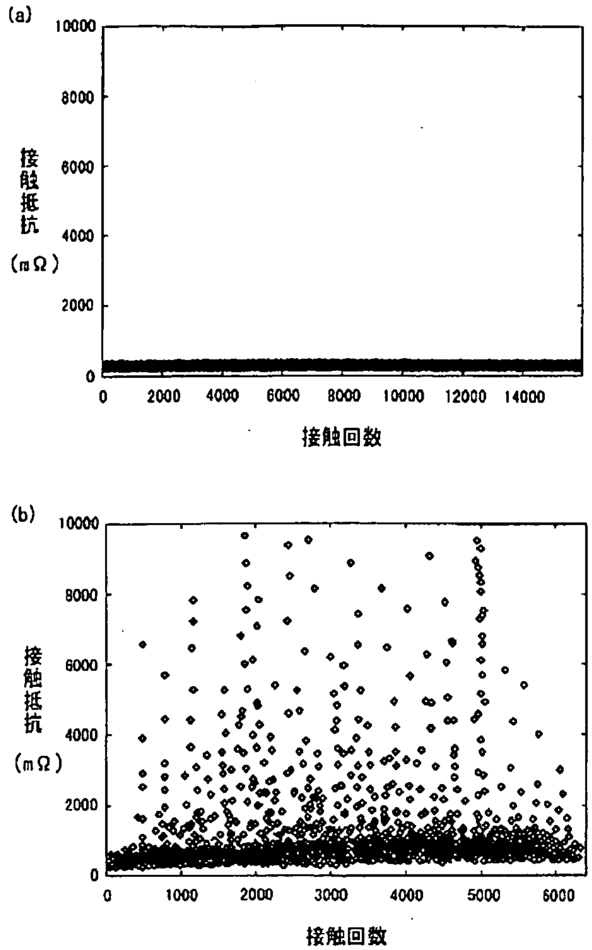
[Drawing 4]



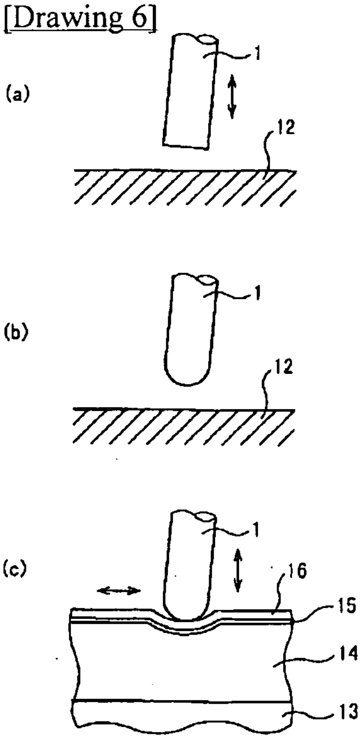
[Drawing 14]



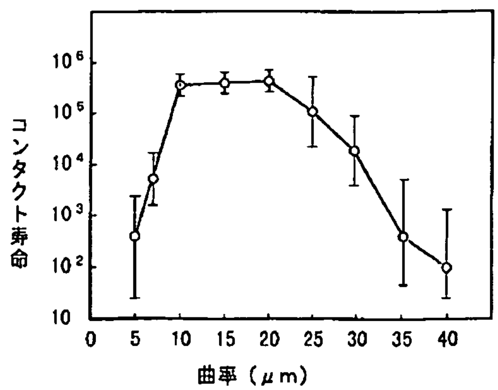
[Drawing 5]



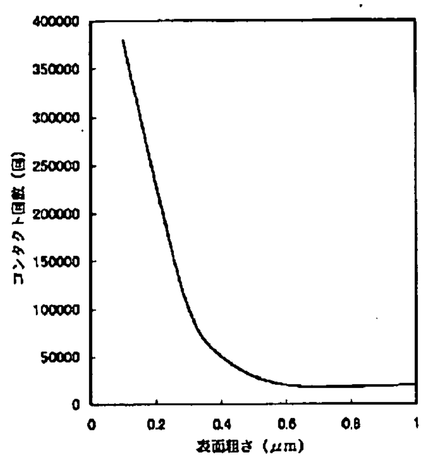
[Drawing 6]



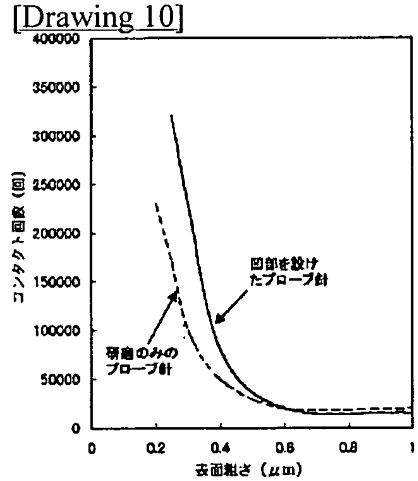
[Drawing 7]



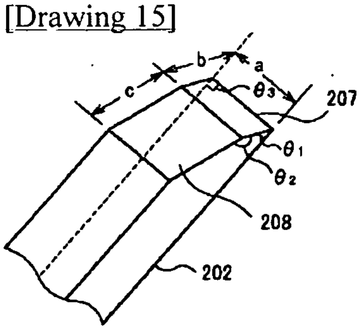
[Drawing 8]



[Drawing 10]

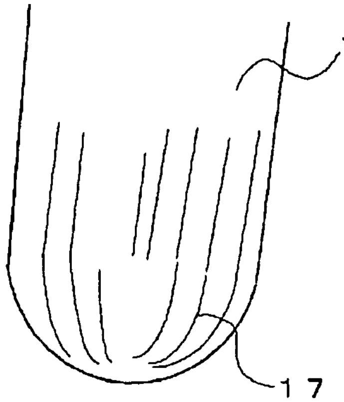


[Drawing 15]

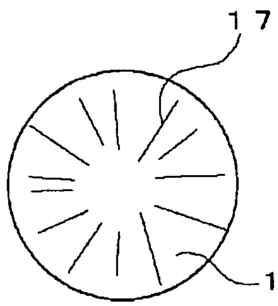


[Drawing 9]

(a)



(b)



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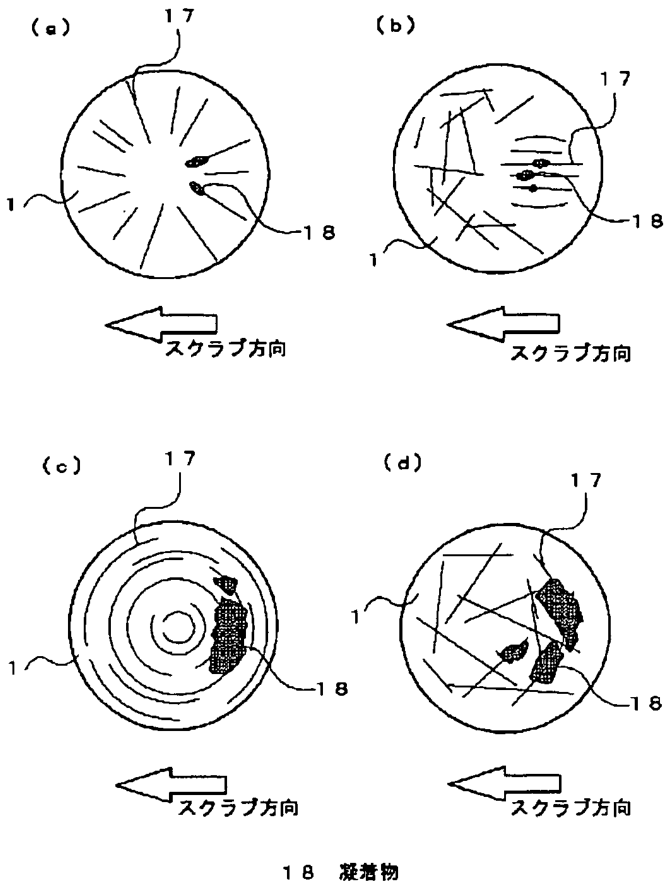
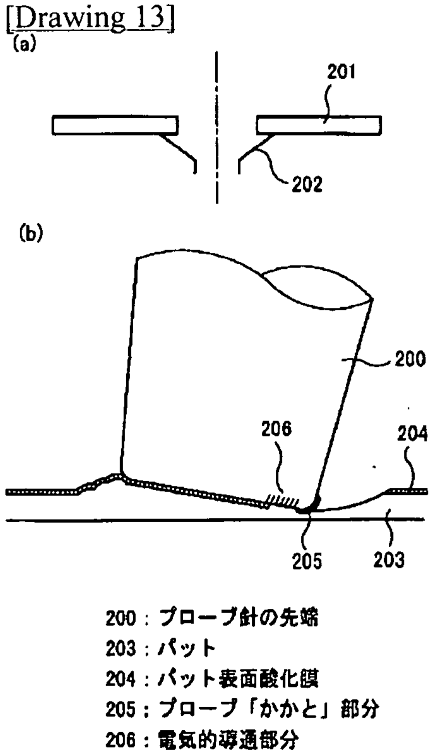
[Drawing 11]



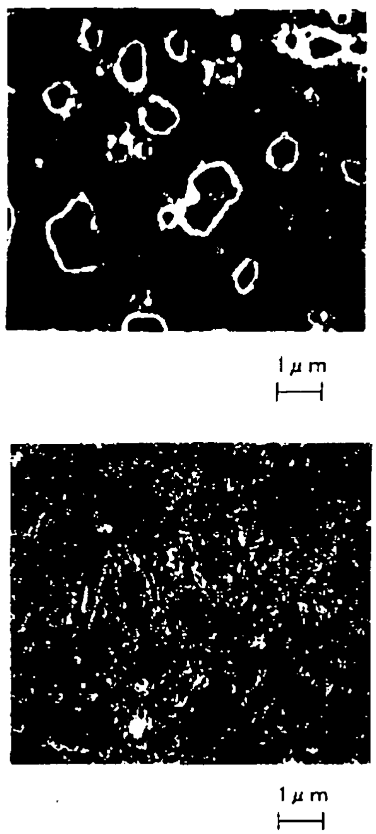
[Drawing 13]



[Drawing 12]

(a)

(b)



[Translation done.]